OPTIMIZING OF STUD CONFIGURATION ON SOCCER BOOT: A FINITE ELEMENT METHOD

NURUL JASMIE BINTI CHE AHAMED

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Faculty of Mechanical Engineering
Universiti Malaysia Pahang

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ABSTRACT

Soccer is one of the famous game in the world and has different boot design for related game. Many design of boot in market that has many functions for every boot. The objectives of this study are to investigate the different materials and designs of stud and to analyze the stud configuration. The materials of the stud between metal and rubber points in the bottom of soccer boot. Three types of football shoes have used to finish this project that are rounded, blade and combination of rounded and blade. The method uses during this research that experiment on force plate and simulation using ALGOR. This study focused on different material on the stud designs which are thermo polyurethane and metal. The design of the stud are rounded, blade and combination rounded and blade using Solidwork. The numbers of stud configuration are 12, 13, and 14. The design from Solidwork based on the already design in laboratory. The result value 977 N/m^2 showed the lower stress on the blade design with number of stud is 12. Based on the result, blade design is the higher stud traction due to the lower stress result than the other two design.

ABSTRAK

Bola sepak adalah salah satu permainan yang terkenal di dunia dan mempunyai reka bentuk but yang berbeza untuk permainan yang berkaitan. Reka bentuk banyak but di pasaran yang mempunyai pelbagai fungsi untuk setiap boot. Objektif kajian ini adalah untuk menyiasat bahan-bahan yang berbeza dan reka bentuk stud dan untuk menganalisis konfigurasi stud. Bahan-bahan stud antara logam dan mata getah di bahagian bawah but bola sepak. Tiga jenis kasut bola sepak telah digunakan untuk menyelesaikan projek ini yang bulat, bilah dan gabungan bulat dan bilah. Kaedah ini menggunakan dalam kajian ini bahawa percubaan pada plat kuasa dan simulasi menggunakan ALGOR. Kajian ini memberi tumpuan kepada bahan yang berbeza pada reka bentuk stud yang termo poliuretana dan logam. Reka bentuk stud yang bulat, bilah dan gabungan bulat dan bilah menggunakan Solidwork. Bilangan konfigurasi stud adalah 12, 13, dan 14. Reka bentuk dari Solidwork berdasarkan reka bentuk yang telah di makmal. Nilai hasil 977 N / m ^ 2 menunjukkan tekanan yang lebih rendah pada reka bentuk bilah dengan bilangan stud ialah 12. Berdasarkan keputusan ini, reka bentuk bilah adalah tarikan stud lebih tinggi disebabkan oleh hasil tekanan yang lebih rendah daripada dua reka bentuk yang lain.

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A	Cross Sectional Area
F	Force
P	Pressure
T	Time

LIST OF ABBREVIATIONS

3D	3 Dimensional
UMP	Universiti Malaysia Pahang

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The introduction of this thesis can be divided into four major parts. Each subsection will discuss the background of the project, problem statement, objective and scope of the project.

1.2 PROJECT BACKGROUND

Recently, football is a very popular game. Football is a tough, physical game requiring a wide range of attributes including explosive power, strength, agility, speed, and physical and mental toughness

The main characteristic of football boots is that they have studs on their soles for the purpose of improving their hold on the ground, usually natural turf. In soccer boots, studs are the elements responsible to traction on the natural turf or artificial turf. Nearly almost all boots in the market has similar soft ground stud configurations and for different design it will have different functions.

Different surface condition will determine the number, type and configuration of the studs on the sole of the boot. Typically, softer, wetter surfaces will require boots with fewer, longer studs, while firmer surfaces need a greater number of small studs.

Nowadays, the design of stud on conical cleats may be either rounded or bladed. Certain rounded design can be removed or screwed in stud with a specially designed wrench, while other conical stud are rounded to the base of boot and cannot be removed. Most studs are made up from hard plastic. Metal studs are also available but are sometimes prohibited in recreational sport due to the possibility of injury on the player.

1.3 PROBLEM STATEMENT

The football players are different in size that means the every single player is different in terms of weight and height. Those differences cause the players to have different stability and force in the performance on the plantar pressure also on the turf.

In the market there are many designs of soccer boot which have the functional benefit of the design. When the players perform, they will find the most suitable shoes or boots to make them comfortable and also for the purpose of preventing injury. The injuries that happened on player during running, braking and direction changes during performing are mostly related to the design of stud itself.

The different design of stud configuration can affect the performance of players. Stud configuration determines whether the players are comfortable or not during performing in running, walking, braking or changing the direction. When the players selected the wrong boot, it will cause injury on the players. The movements of players on the field are highly depending on the stud configuration.

1.4 OBJECTIVE

The aim of this study is to optimize the stud configuration on soccer boot by using finite element method. The specific objectives of this study are as follows:

i. To identify the different materials and designs of the stud.
ii. To analyze the stud configuration with different number of stud.

1.5 SCOPE OF PROJECT

The scope of this project can be narrowed down into three points. They are as follows:

i. The different of material on the stud design which are thermo polyurethane and aluminium alloy.
ii. The design of the stud is rounded, blades and combination rounded and blades.
iii. The numbers of stud configuration are 12, 13, and 14.

1.6 ORGANIZATION PART

Chapter 1 of this thesis is about the background of the project that is soccer boot and also the different designs of soccer boot available in the market. This chapter also includes the problem statement which is caused by stud configuration and the objective of this study which is to optimize the stud configuration on soccer boot using different design of soccer boot and different movement. The scopes of this project are to study on different material, design of stud and different number of stud configuration with different movement of the players.

Chapter 2 presents the literature reviews which focus on the recent studies or research by authors related to stud configuration of the soccer boot. The formation about the materials that always used in fabricates the stud on soccer boot. The literature

review can be approximately close to the titles of the project also. From this chapter, the author will get more knowledge about the results of the previous researches and can predict the result of the project.

Chapter 3 is the overview the preparation of the title project that can run with simulation and experiment. This chapter can overview of software application to simulate the force of the footwear in gait is presented .Three soccer boots that already selected with different stud configuration can use in an experiment and simulation by the drawing in Solidwork. This project has one experiment that is experimenting on a force plate. After getting the data from the experiment on force plate, the simulation can run using the ALGOR software.

Chapter 4 focuses on the outcomes of the research and discussion. High speed camera is used to detect the movement of the player when different designs of soccer boot are used. The result need to compare for the experiment and simulation. This project is on making comparison on stud configuration between different brands and function by using finite element method. The configurations are related to the stability of player. Develop finite-element model will be validated with experimental data. The model was developed to understand the better design of stud that will use to the players.

Chapter 5 focuses on the conclusions of the project and recommendations for future work. This chapter also will summarize both the results from experiment and simulation. The result must be validated between experiment and simulation. The conclusion of this chapter when objectives of the project that can achieve.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The literature review of this thesis is divided into five parts. The first part of the literature reviews is on the introduction to material of stud configuration. It also includes the type of material that usually use in stud or cleat. The second part of the literature review give the different design of soccer boot stud that are rounded, bladed, and the combination of rounded and bladed. This part can explain detail the function or application of their design. The third part discuss about the movement in playing football and the reaction between shoe outsole and the surface of the turf. Then the fourth part can discuss about force plate use as an equipment to run this project. The last part will discuss about the Algor Software. The sources of the review are extracted from journals, articles, reference books and also internet.

2.2 MATERIALS OF STUD CONFIGURATION

Three different designs of soccer boot available in the laboratory are used in completing this study. The studs of two of the three designs are made up of rubber type and the other one is made up of aluminum. Different materials of stud will affect the soles grip on the field's surface. For synthetic field, in order to get a good grip, the surface must use the blades of hard plastic hard stud. Good surface condition will offers the optimum adhesion in translation and most probably the lowest in rotation (Vachon et al 2002). According (Grund and Senner, 2010) the test must include the material that usually interacts the force between athlete and surface but the design of apparatus as laboratory device is the best method for testing the football shoes.

2.2.1 Rubber Stud

The rubber is the main material used in the outsole of soccer boot. Thermo polyurethane is one of the rubbers that are used in the design of rounded and bladed. This is a softer material that can offer a greater degree of comfort to the user. It is named as bladed because they look like knife blades that are attached to the sole of the shoe in a circular pattern. This type can suit in firmer condition or surface. On these surfaces, the heels face greater impact with the surface. So, the studs will be slightly longer on the hill than the front area of foot and around the toes.

Figure 2.1: Rubber blade design

Source: (http://www.google.com.my/search?q=rubber+stud+design)

2.2.2 Steel Stud

The steel stud is a minor material for football boot studs and is nearly always removable or screw in stud so that different length can be utilized depending on the surface of the pitch. It is required on soft ground as their grip is deeper. On soft ground, the user will not feel the effect of the reduced comfort found in steel stud.

Figure 2.2: Steel rounded design

Source: (http://www.google.com.my/search?q=steel+stud+design)

2.3 DESIGN OF SOCCER STUD

There are three different designs of soccer boot which are rounded, bladed, and the combination of rounded and bladed. Every design has different functions so that the players can choose the most suitable design depending on the surface condition. The most specialized piece of equipment for football is the boots that players will wear during playing and training. This is also likely to be the largest single expense for player's so it is important that the players get a pair of boots they will be comfortable wearing for long periods of time and which are versatile enough to adapt to the many different surfaces they will play on throughout a season.

Design of stud plays an important role in games for traction and penetration of the surface. It also to grip the football boots that enhance the performance of the activities, and especially during acceleration (sprints), brake and change direction. The types of studs are the most important elements and also to avoid the injury occurred (Gonzalez et al 2008). The normal load on studded boot can generate the traction and the interaction between shoe surface interfaces. Increasing the number of studs give effects on the decreased in the performance of the subject.

2.3.1 Rounded design

Football boots with rounded studs are usually best used on dry pitches. They tend to have more studs than other football boots and provide better support over a wider area, also reducing blisters. This is because the larger number of studs distributes the pressure more evenly on your foot. If feet are suffering on hard pitches with blisters, then rounded studs or using shorter screw-in studs that are designed for harder pitches is preferable.

Figure 2.3: Rounded design

Source: (http://www.google.com.my/search?q=blade+stud+design)

2.3.2 Bladed design

Football boots with a bladed soleplate are most frequently used on surfaces which are somewhere between soft and hard, although some bladed football boots now have interchangeable blades to better suit the surface. The blades are designed to make turning easier. Studies done on two different types of fields shows that their complex geometry of blades stud has good penetrating properties (low cross sectional areas) than that round stud but its perpendicular to the shoe sole under normal impact. The design of the blade is believed to precipitate more injuries and its react like a knife in contact situation (Bently et al 2011).

Figure 2.4: Blade design

Source: (http://www.google.com.my/search?q=blade+stud+design)

2.3.3 Combination of rounded and bladed design

Most popular with the amateur, the screw-in studded boot can be interchanged depends on the surface conditions. For example, in wet conditions with very soft ground, long stud is required whereas in dry conditions, a shorter stud is used. Usually, the positions that use the combination is shooter long range. These easy to grip the surface when shooting the ball.

Figure 2.5: Combination of rounded and blade

Source: (http://www.google.com.my/search?q=combination+stud+design)

2.4 FINITE ELEMENT ANALYSIS

Finite element analysis (FEA) consists of computer model of a material or design that is stressed and analyzed for specific results. It is used in new product design, and existing product refinement. In other words, FEA is a numerical method to find out an approximate solution for variables in a problem which is difficult to obtain analytically.

The concept of the finite element analysis is solving a continuum by a discrete model. It is done by dividing the problem into several small elements. Each element is in simple geometry and this is easier to be analyzed than the actual problem or the real structure. Each element is then applied to known physical laws.

The aeronautics, automotive, defense, and nuclear industries had started using the finite element application since early 70's. However, this is limited to expensive mainframe computer. Zienkiewicz and Cheung was the important person in developing the finite element technology at that time. But later, Hinton and Crisfield carried out the finite element into modeling and solution of nonlinear problems (Reddy, 1993).

With the development of the CAE technology, engineering drawing can be produced. Besides, the analysis can be carried out and also the Finite element modeling can be done. The finite element becomes more and more important today which can simplify and solves various types of engineering problems.

2.4.1 Finite Element Analysis

FEA uses a complex system of points called nodes which make a grid called a mesh. This mesh is programmed to contain the material and structural properties which define how the structure will react to certain loading conditions. Nodes are assigned at a certain density throughout the material depending on the anticipated stress levels of a particular area. Which regions will receive large amounts of stress usually have a higher node density than those which experience little or no stress. Points of interest may consist of: fracture point of previously tested material, fillets, corners, complex detail, and high stress areas. The mesh acts like a spider web in that from each node, there extends a mesh element to each of the adjacent nodes. This web of vectors is what carries the material properties of the object, creating many elements (Peter Widas, 1997).

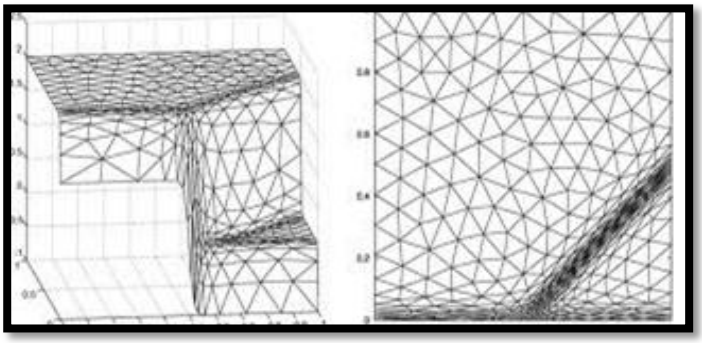

Figure 2.6: Mesh diagram in 3D model

Source: (http://www.google.com.my/search?q=meshing+design)